A Mystery of One Havana Portrait: The First Steam Machine in Cuba

Olga V. Egorova

Abstract An iconographic detail as well as some archive documents help us to prove that the first steam machine, or the "bomb of fire" as it was called in the eighteenth century, introduced in Cuba in 1797, was constructed according to the project and under the direction of the father of modern engineering in Spain and Russia, Agustin de Betancourt y Molina who was not only a great inventor and engineer, architect and city constructor, but also one of the founders of science "Theory of Machines and Mechanisms" (TMM). He was born on February 1, 1758, on the island of Tenerife and during his life managed to visit many countries – France, England, Germany, Russia, but he never came to Cuba. However he figured prominently in the development of innovative technical ideas of the Island.

1 An Iconographic Detail

In a corner of the "Plaza de Armas" (Weapons Square) (Fig. 1), the most ancient part of Havana, there stands the Palace of Captains-Generals (Fig. 2), an important example of civil architecture of the eighteenth century. It was designed by the famous Cuban engineer and architect Antonio Fernandez de Trebejos, and was constructed under the guidance of the Captain-General Felipe de Fonsdeviela, Marquis de la Torre, a notable Governor and urbanist .

Many years passed before the Palace was opened in 1791 by the Marquis de la Torre's successor, illustrious Spanish, Don Luis de las Casas-and- Aragorri (1745–1800), the best Governor that Cuba ever had and the one who contributed much to the prosperity of the country (Fig. 3).

Among the most interesting collections in one of the second floor rooms of the Palace of Captains-Generals – today the Museum of the City of Havana – we can

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Fig. 1 Plaza de Armas

find a portrait of Ignacio Pedro Montalvo y Ambulodi (1748–1795), the first Count de Casa Montalvo. The potrait (Fig. 4) was painted by Creole Juan del Río, probably about 1794 or 1795, shortly before the Count's death. This important and noble figure was born in Havana and later became one of the founders of the Royal Economic Society of Friends of the Country (Real Sociedad Económica de Amigos del País – SEAP).

The Count de Casa Montalvo was considered to be one of the most powerful and influential landowners of his epoch, possessing not less than 9 sugar-mills (ingenios), 500 slaves, 5,500 knighthood of ground (73,700 ha) and 14,000 head of cattle. Seibabo and Montalvo villages, placed to the southeast of the capital in the most fertile plains, between San Antonio-de-las-Vegas and San Jose-de-las-Lajas towns, was part of his property (Cornide 2003).

In the legend placed in the lower part of the portrait and briefly defining the subject we read:

> Mister Don Ignacio Montalvo de Ambulodi Count de Casa Montalvo, Honorable Gentleman of Chamber of His Majesty and Brigadier of the Royal Armies. Colonel of Regiment of Dragons of Matanzas Village, Caballero of the Order of the Saint Jacob and the first named by the King prior of the Royal Consulate of this Island. Fellow (Full member), Royal Economic Society.

Fig. 2 Palace of Captains-Generals

While viewing the portrait we should notice one attractive detail – an incomprehensible drawing that the figure of the Count indicates with his right hand. What mystery does it keep? More attentive investigation helped us to prove that it is a drawing of the first steam machine, or the "bomb of fire" as it was called in the eighteenth century, introduced in Cuba in 1797, and the one that was constructed according to the design and under the direction of the father of modern engineering in Spain and Russia, Agustin de Betancourt y Molina.

We could easily compare the machine made by Betancourt by his own hand (Fig. 5) and presented to the Academy of Science in Paris, with the drawing on the portrait of Count de Casa Montalvo and determine that they are almost of the same shape (Fig. 6) (Egorova 2010).

It was not insignificant that the drawing of the steam machine was put in the corner of the portrait; it represented the lineaments of the painter and his epoch. Among the most famous colonial plastic artists of the time, the Creole Juan del Río (1748–18.?) was known as a painter of religious matters and a good portraitist. He was believed to be a student of Vicente Escobar, but it is also true that in his pictures

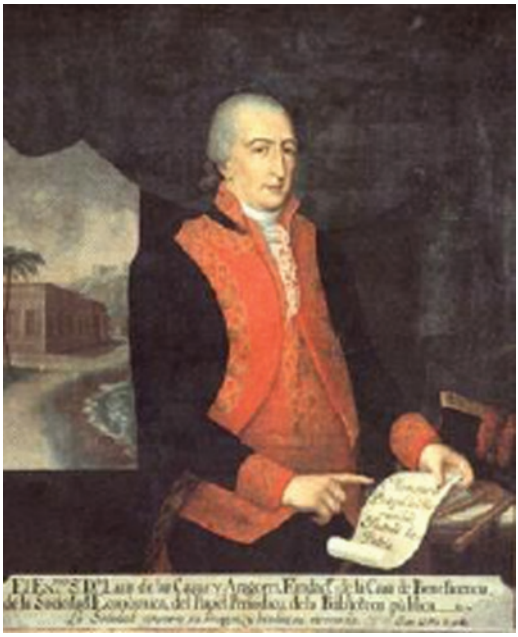

Fig. 3 Luis de las Casas y Aragorri

Fig. 4 Count de Casa Montalvo

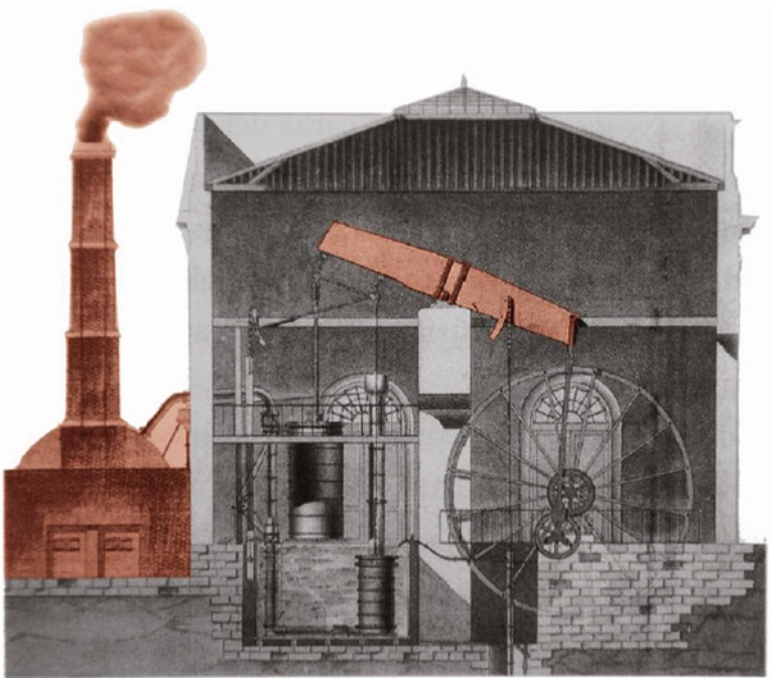

Fig. 5 Vapor machine made by Betancourt

Fig. 6 Drawing on the portrait of Count de Casa Montalvo

he shows a style quite different from his supposed teacher. The first del Rio works we know of are dated in the last decade of the eighteenth century. Unquestionably, his primary masterpiece is the wonderful and eloquent portrait of Luis Ignacio Caballero. Not coincidentally the Royal Society (SEAP) considered Juan del Río to be their chief portraitist and ordered him to paint the portraits of the most powerful Havana personalities: Governor, Bishop and noble members of the aristocracy.

It is known also that the lineaments of the Creole painter who signed the foot of his works: "Juan del Río painted it", were reproductions of some very important subject, or object, or symbol of the person he portrayed. For example, on the portrait of Don Luis de las Casas, who had ruled since 1790 up to 1796 on the Island, there appeared a rendering of the Royal Welfare Home, later known as the Royal Consulate of Agriculture, Industry and Commerce, which Don Luis founded. Another del Rio painting, also kept in the Museum of the City, is the portrait of Salvador del Muro y Salazar, Marquis de Someruelos (1754–1813), Captain-General from 1799 up to 1812, who is represented along with shelves of books. It is legendary to us that this Marquis was the founder of the Public Library and headed it for 12 years and 11 months.

So we can say that the above mentioned iconographic details, very typical of the Enlightenment epoch and of Juan del Rio in particular, help us to clarify not only some biographical and genealogical information, but also some historical facts, as it is the case of the first steam machine introduced in Cuba.

2 Brief Biography: Agustin De Betancourt in Spain and France

Agustin José Pedro del Carmen Domingo Candelaria de Betancourt y Molina (that is his full name) (Figs. 7 and 8) was born on February 1, 1758 in Puerto de la Cruz (Tenerife, Canary Islands, Spain) in a noble and aristocratic family. From 1778 to 1784 he studied in Madrid at the school named "Reales Estudios de San Isidro" and currently at the Royal Academy of San Fernando, where the world famous romantic painter Francisco José de Goya y Lucientes (1746–1828) studied at the same time (García-Diego 1985).

In March 1784, as a capable student, Betancourt was sent to Paris where he participated in the activity of the School of Bridges and Channels (École des Ponts et Chaussées). But very soon he went back to Madrid and, after an interview with the Secretary of State Don Jose Monino, the Count de Floridablanca, he was asked to establish in Spain a new school, namely, the School of Roads and Channels (Escuela de Caminos y Canales).

The agreement with Floridablanca included also the following tasks (AHN 4088):

- select students for the "École des Ponts et Chaussées" in Paris, where they could in future obtain the degree of Hydraulic Engineers;
- educate and train experts in mechanical engineering;
- collect models and drawings of machines that were known at that time and used in industry, agriculture, transport and other fields.

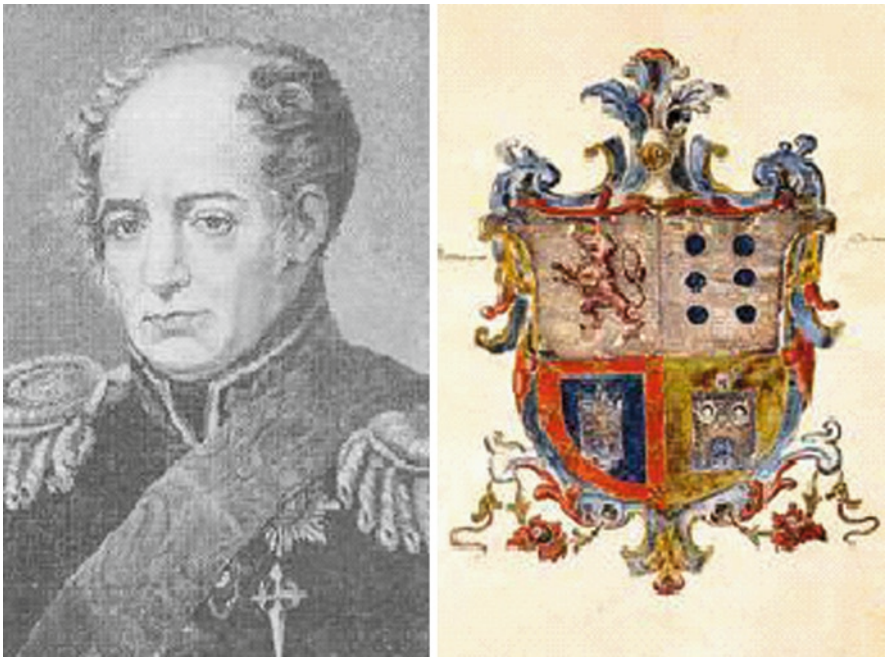

Fig. 7 Agustin de Betancourt and his family coat of arms

Fig. 8 Alexander I, Emperor of Russia

To fulfill the agreement, on September 10, 1785, Betancourt went again to Paris, where he was warmly welcomed by the Director of the above mentioned School – Jean Rudolf Perrone (1708–1794) and Professor of the School – Gaspar François de Prony (1755–1839).

One day in April, 1788, the Spanish ambassador, the Count Fernan-Nunez, who on occasion visited Betancourt's home-workshop in Paris, was so impressed with the great number of scale models of machines and engines, collected and built by Agustin, that later in his letter to the Secretary of State, dated 23 April, Fernan-Nunez proposed the creation of a Royal Cabinet of Machines in Madrid on the base of this collection (AHN 5910–5990).

In 1791, in view of the unstable situation in France, the king of Spain Carlos IV decided that Betancourt should return home, to Madrid, and that he should bring with him all he had as an assemblage. The whole collection was received in Spain between July and September and in April 1792 the Cabinet, located in the king's house "Palacio del Buen Retiro", was opened to the public. On the 14th of October Betancourt was officially appointed as the Director of the Royal Cabinet of Machines. The whole collection was composed of 271 models, 359 drawings and 99 memoirs, and a vast library of rare books and manuscripts. Thus, the first-ever world museum on Science and Techniques History was established.

By the end of the eighteenth century Betancourt was already considered to be one of the greatest and best-known engineers of Spain. In 1802 he was appointed to the position of Chief Inspector, and also established the School of Roads and Channels, which was located at the Royal Cabinet of Machines. From 1802 to 1807, he worked at the School of Roads and Channels, the Royal Cabinet of Machines and the General Inspectorate of Engineers of Roads corps.

3 Activity in Russia

In October 1808 because of the unstable political situation in Spain, complicated family reasons or other causes, Agustin de Betancourt moved to Russia to work under the auspices of Emperor Alexander the First (Fig. 8) by the Czar's private invitation. After his arrival he was accepted in November 1808 into the Russian military service and was appointed to the rank of General-Major. In Russia, Betancourt exerted great efforts to develop, successfully, an engineering framework through a number of activities in designing, teaching, and organizing in many fields of engineering until his death in 1824 in Saint Petersburg. Betancourt's activities were fully appreciated and still today there is a great admiration for him in Russia (Egorova and Ceccarelli 2006).

The beginning of Betancourt's activity in Russia coincided with his 50th anniversary. He came to a new country with all his family: wife Anna, three daughters and son – Carolina, Adeline, Matilda, and Alfonso.

It is known also, that a year before, in November 1807 under the recommendation of the well-known Russian diplomat Ivan Mouraviev-Apostle who was the Secret Adviser of Foreign Affairs Colleague and the Envoy of Russia in Madrid from 1802

to 1805, Betancourt visited Russia for the first time in order to get acquainted with a new (to him) country and to discuss an opportunity to join the Russian Military service. He was received by Count Nikolav Rumyntcev (Minister of Commerce from 1802 to 1811 and Minister for Foreign Affairs from 1808 to 1812) with great courtesy and a little later presented to the Emperor for a private audience (Russia and Spain 1997). It is obvious that for Betancourt, a nobleman, the attitude toward him on the part of high-ranking officials and the Russian Czar in particular played an important role and was quite possibly the determining factor in his choice to move to Russia.

It is difficult in a short article to estimate the heritage that was left by Betancourt to his new motherland – Russia. Even an enumeration of the towns (Tsars Selo, St-Petersburg, Tula, Kazan, Warsaw, Tver, Moscow, Nizhniy Novgorod) where Betancourt's projects have been built can give us only a limited image of it. For 16 years he preside over a staggering number of engineering projects; he invented a mechanical dredge with a steam engine for clearing Kronshtad port water area, improved the army industry, designed and built bridges using a new system of arches, etc. Being a talented engineer and a great organizer he tried in his own words, to turn Russia into one of the most advanced countries of that time.

In 1817, according to his design, the Riding-School of Parades (Manege) was built in Moscow (Fig. 9) with the sizes inside the walls 166.1 by 44.7 m (Betancourt 1819).

He offered an original design of an overlapping construction made from wooden rafters. The arena had no inner support, and the rafters in lengths of 44.86 m supported the entire space. Such an engineering design was unique at the time. On the 30th of November, the same year, the Manege was opened for public and social celebrations. Its area consisted of about 7,500 m^2 and could hold more than 2,000 people. Betancourt's contemporaries wrote that "in formidability, in architecture and designs of a roof precisely are not present in Europe similar" referring to the unusual combination of wood and metal that gave to the design durability and simplicity (Egorova 2006).

Betancourt-engineer developed special fixing elements due to which two details from a wood did not adjoin among themselves. The innovation consists that on the end of every rafter had been used a tip from the bleached iron that interfered direct

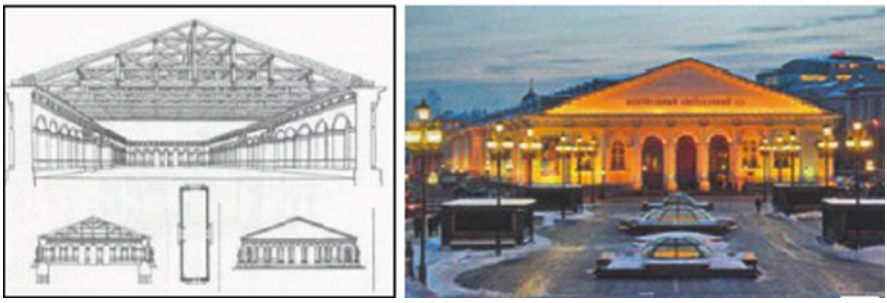

Fig. 9 Moscow Riding-School (Manege)

Fig. 10 Moscow Manege today

friction of wood in other parts of a sup-porting arch. Betancourt had taken advantage of his own experience of building the Kamenoostrovsky Bridge over the Malaya Nevka River in Saint Petersburg where he had connected seven large wooden arches with similar elements.

In his Manege design Betancourt tried to exclude all possible risks which could arise in the future, for example the likelihood of flooding because of a very close Moscow-River location. So, he ordered the base to be deepened by 4 m and the walls to be made thicker at the bottom. The roof of a particular building had been specially designed under asymmetric loading, because a layer of a snow could be unequal on the shadow and solar sides (Fig. 10).

Among Betancourt's main achievements was establishment of the first-ever in Russia Higher Engineering School that was named the Institute of Corps of Engineers of Routes of Communication – ICERC (nowadays Petersburg State University of Means of Communication).

The Institute was established according to a document signed by Alexander I, Emperor of Russia, 20, November, 1809, where there is a paragraph about the organization of the Corps and the Institute of Corps of Engineers of Routes of Communication. It is important to point out that, from the very beginning, Betancourt participated in the activity of the commission for developing the project called by for this document. For his excellent work in this commission he was promoted to the rank of General-Lieutenant and on August, 30, 1809 was appointed as the Institute Inspector. Later in 1816 he was appointed to the post of President of the Committee for Constructions and Hydraulic Works and in the same year he organized an important fair in Nizhniy Nóvgorod. In 1818 he was nominated as Chief of Department of Routes of Communication.

Fig. 11 First building of the Institute

Betancourt chose the Manor of the noble Yusupov family as the first building for the Institute because it was surrounded by a wonderful park with a lake where all students could gather during breaks, and it had also a lot of large and light rooms for lessons (Fig. 11).

To develop a new educational system Betancourt made use of his own experience of the establishment of the above mentioned School of Roads and Channels in Madrid. Based also on achievements of his French teachers: Gaspar Monge (1746–1818), the founder of the Polytechnic School, and Jean Rudolf Perrone (1708–1794), the founder of the School of Bridges and Roads, he did not simply repeat the western style of teaching in Russia, but he made a significant improvement as specifically adapted to Russia's environment in such a way that it was a new type of higher technical education which still, two centuries later, maintains significant value.

By the beginning of the nineteenth century in France there was already a numerous staff of engineers, and therefore Betancourt could invite qualified experts for teaching special disciplines in the Institute of Engineers of Routs of Communication in Russia. The first 20 years of teaching at the Institute was carried out in French and this permitted students to study the latest proceedings on engineering inventions from original documents and early publications. The program and curricula were defined by Betancourt while providing simultaneously scientific, engineering and practical training that was an innovation for Russia and, as a whole, advanced at that time. Theoretical teaching of students was combined with their practices in laboratories and workshops, even outside the Institute, by including intensive work on design and drawing. All that gave a profound basis for good professional young specialists.

The approach of the new program was verified by time, and became an example for other higher technical schools through the nineteenth century. Russia at that time was in great demand of the new generation of professionals capable of designing a wide spectrum of engineering projects. Major principles of the new educational system were:

1. Serious general-theoretical education of students with a strong basis in mathematical disciplines;
2. Universal approach to engineering activity on the basis of a wide culture, providing a creative orientation of graduates;
3. Development of practical skills of students for working with mechanisms and machines;
4. Practical training under real conditions.

The main aim of an education program as Betancourt liked to repeat was "to supply Russia with engineers who after graduation from the Institute could immediately be effective in industry". He wished all students of the Institute "should be familiar with the basis of science and its practical application to engineering". The Institute of Corps of Engineers of Routs of Communication really became "that trunk" of Russian higher technical school from which all the numerous branches were formed later.

From the very beginning, parallel with the Institute, Betancourt started to organize a library and a room for practical studies. For that purpose the first books, various tools and scale models under his order had been purchased in Paris and in 1810 delivered to Saint Petersburg.

With a view to continuity, the best graduates stayed in the Institute and later became well-known professors and scientists. One of the most talented graduates of 1813 was A. D. Gotman (1790–1865) who later became the Rector of the Institute from 1836 to 1843.

Betancourt paid very special attention to manuals. From 1816 the Institute began to lithograph and to issue professor training courses and lectures. In "Voenii journal" (Military magazine) from 1811 it was remarked, that "higher mathematics and mechanics in Russia are taught in the only one Higher School – the Institute of Corps of Engineers of Routs of Communication where the well-known General Betancourt introduced it recently".

Among special disciplines for the high level of engineering teaching, the "Course of construction", was developed by M. S. Volkov. The new course included methods of designing and construction of all transport overland and hydraulic engineering systems and it included as important sections: building materials, building mechanisms, manufacture of civil construction, highways, bridges, hydraulic engineering.

The second significant course was Applied Mechanics. In 1821 it was allocated as an independent subject from "Theoretical mechanics". This course provided knowledge in steam machines, building and road mechanisms and all other mechanical devices and machines that are connected to construction and operation of transport constructions and water supply.

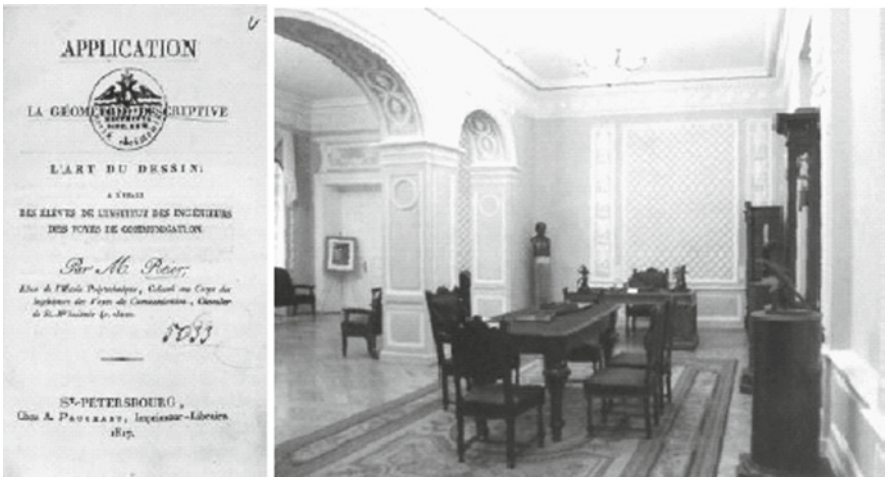

Fig. 12 "Basis of descriptive geometry" by Charles Potier and Betancourt's Cabinet in the Institute

In 1823 "Note about appendix of the beginnings of mechanics to calculation of action of some of machines, the most common" by professor D. S. Chizhov was published as the first textbook on Applied Mechanics in Russia.

As a whole from 1816 to 1828 several courses were published or litho-graphed: "Lecons de mecanique applique" by B. Clapeyron, "Traite des proprietes projectives des figures" by J. V. Poncelet, "Traite elementaire de calcul integral" by Pierre Bazaine avec Gabrial Lame, "Basis of De-scriptive Geometry" by Charles Potier (Fig. 12), translated into Russian by J. A. Sevastjanov, "Spatial Geometry" by A. I. Majorov, "Initial bases of analytical geometry" by J. A. Sevastjanov, "Differential calculus Initial base" and "Integral calculus Initial base" by P. Bazaine (in French), "Base of Mechanics" by Morice Destreme, etc.

Betancourt managed to organize a Museum of Models in the Institute by using his own previous experience of the Royal Cabinet of Machines in Madrid. It was opened in the "Special hall" only in 1813 after the first exhibits arrived. The Museum consisted of six cabinets: modeling and mechanical, building – working tools, samples of building materials, physical, geodetic, mineralogical. In those cabinets practical lessons were given. The collection of the Museum was continuously enriched with scale models, drawings concerning construction of bridges, channels and buildings. The collection helped to study disciplines more deeply using all the knowledge in practice. Students were used to make scale models and mechanisms in workshops of the Institute (thus, in the Museum there are 14 models of Descriptive Geometry, some models and mechanisms made by Betancourt himself or under his supervision, Fig. 13).

Betancourt's basic efforts were directed toward education of qualified Russian engineers on a European level. He became the founder of professional traditions

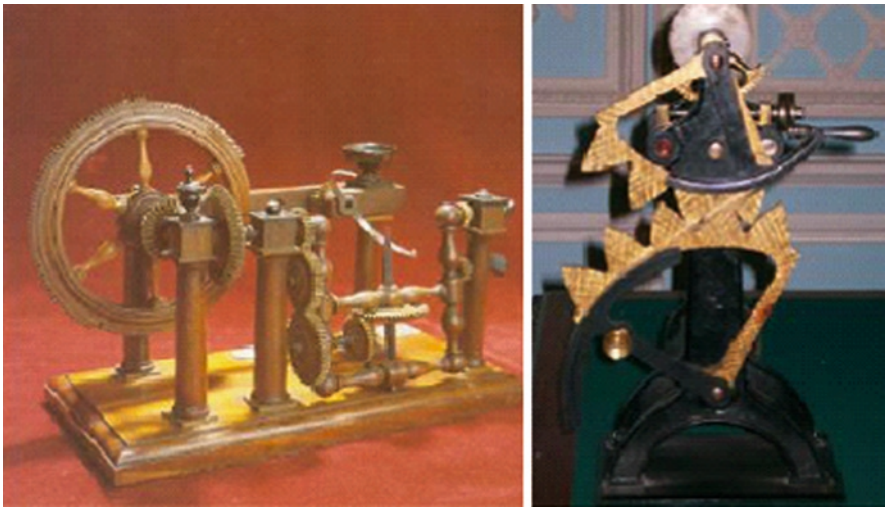

Fig. 13 Mechanisms fabricated by A. Betancourt

which even nowadays provide the country with qualitative experts in mechanical engineering, construction of bridges, roads, and buildings.

Betancourt's contribution to establishment of Russian higher engineering education was truly significant. The young scientists who graduated from the Institute established a Russian scientific language by translating textbooks into Russian terminology and adapting the Institute's system of engineering training to Russian culture.

The Institute of Engineers of Routs of Communication became a cradle of Descriptive Geometry in Russia, because the theory of this branch of mathematics was well developed and many new applied disciplines appeared on its basis. Monge's dream: "young experts will apply Descriptive Geometry in many areas and use it for machine construction and then a human being using the power of nature will need only add the power of his brain" came true.

With the advent of railways Russia immediately has joined the European community of railway construction because it had produced super professional engineers and they all were Betancourt's students – graduates from the Institute. They were able to solve any kind of problem: technical, cultural national. And, certainly, they had always Betancourt's example to follow.

Students of the Institute received the highest technical and engineering education ever known in Russia. The intellectual scope of the theory, experience and talent in Engineering and Pedagogics helped Betancourt to establish a new educational system with huge potential opportunities. It is remarkable, but Russian engineers of the nineteenth to twenty-first centuries cannot be reproached for lack of competence or scarcity of imagination.

In his activity Betancourt followed principles of the well-known Roman architect and engineer Vitruvius: durability, common weal, beauty. Thus those few guidelines assured that Betancourt's designs were not only engineering constructions, but also masterpieces of art. Primitive service for momentary benefit was alien to him. He used to say: "In technical equipment it is not enough to get the desirable result, it is necessary to use the most simple, easiest, strongest designs and most suitable to the workers skills".

Petersburg University of Routs of Communication, founded by Betancourt, became one of the leading Russian scientific educational centers, the foremost higher engineering institute in the country.

Still it is interesting that before his coming to Russia, Agustin de Betancourt had a real plan for working in Cuba, but the wars and hidden intrigues prevented him from following Columbus' steps and he never went to Cuba. Nevertheless, the Spanish engineer played an important role in the development of innovative technical ideas in Cuba.

4 Cuba as a Part of Spain's Empire

For a long time Cuba held an important place in the imperial economy of Spain. Without gold and silver deposits and with an insufficient working population, economic activity in the Island was concentrated in the port of Havana (Fig. 14) because of its excellent position on the Gulf of Mexico for ships to dock and trade.

Spanish King Charles III died in 1788 and the throne was occupied by Charles IV, a king who was weak and without real power. Spain was governed by Maria Luisa and her favorites; her main support was Manuel Godoy (Fig. 15), officer of

Fig. 14 Havana port

Fig. 15 Manuel Godoy, fragment (By Goya)

Fig. 16 Francisco Arango y Parreno

the guard. At the age of 25, he was named Prime Minister. Under his tutelage, political power in Cuba passed into the hands of the Cuban bourgeoisie, more known as "saccharocracia", which means related to the sugar production. One of its most prominent representatives was Francisco de Arango y Parreno (1765–1837) (Fig. 16) owner of vast lands and an intellectual. He was born in Havana on May 22, 1765 in a family of elite ancestry and with large economical resources. Francisco de Arango headed Havana's saccharocracia and became one of the most devoted fighters for reforms in Cuba.

At the end of the eighteenth century, the "Century of Light", under the direction of the Governor Luis de las Casas there appeared in Cuba some institutions, that made important contributions to the development of the country. The above mentioned Economic Society (SEAP) and the Royal Consulate of Agriculture, Industry and Commerce were founded, and the first daily newspaper "El Papel Periodico-de-La-Habana" was established.

Luis de las Casas also, with good will, received refugees from Haiti after the rebellion of slaves, which took place there in 1791 and gave them credits and lands in the eastern part of the Island. The new colonists had great experience in the production of coffee and sugar. In this way, more and more plantations and sugar-mills appeared in Cuba. At the end of the Eighteenth century in a very brief time, Cuba surpassed Haiti as the most important sugar producer and exporter of the epoch.

5 Sugar-Cane Production in Cuba

Sugar cane started to be cultivated in Cuba at the end of the sixteenth century. The sanction that had been given first to Santo-Domingo was accepted in the Island in 1595. Still, only in the middle of the eighteenth century was the real cultivation and sugar manufacture started, which immediately took one of the most important places in the Cuban economy.

Sugar production was based on the juice of sugar-cane called "*guarapa*", which was produced by means of wooden tools which were called "*trapiche*" or "*cunyaya*". According to Fernando Ortiz, a famous Cuban historian, a "cunyaya" (Fig. 17) was a rudimentary device similar to a press used by Greeks and Romans in antiquity to press olives to produce oil.

The Cuban historiography uses words "sugar-mill", "trapiche" or "ingenio" to identify the unique existing mechanical engineering in sugar production of the

Fig. 17 Primitive cunyaya (Trapiche)

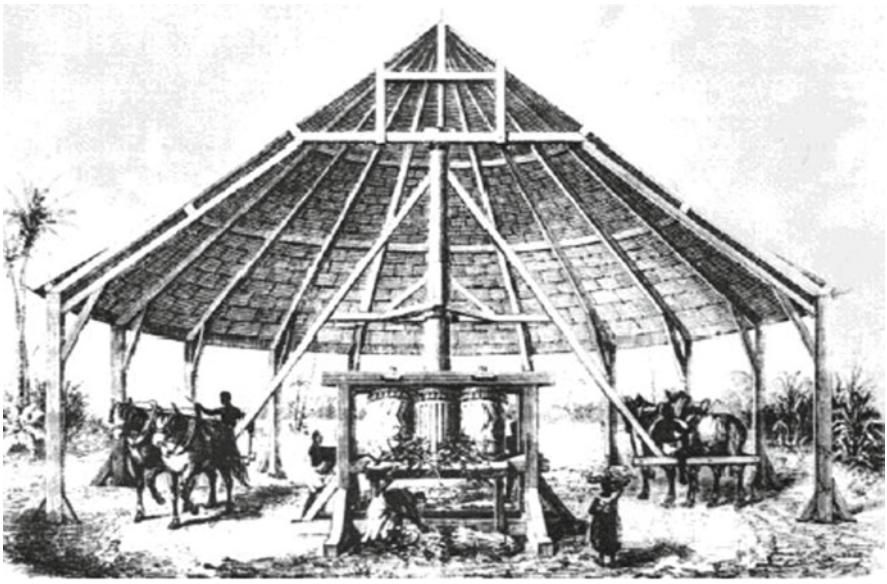

Fig. 18 Sugar-mill (Trapiche) using power of animals

seventeenth to eighteenth centuries. Trapiches as inventions used a similar mechanism, made in the beginning, of two placed cylinders made from firm wood in a horizontal form.

Later, this technology with application of a system of three vertical cylinders, wood or iron which rotated in a form contra each other was improved, wiping and squeezing out sugar-cane with greater intensity. However, it was actually differentiated by its driving force. First, trapiches were drived by mules, donkeys or horses, according to what was available to a landowner (Fig. 18). Animals, with covered eyes, moved in a circle, turn after turn, attached to levers of a mill which actuated the central wheel, and then moved the system of cylinders.

Trapiches could be also moved by hydraulic force (water mills) (Fig. 19) or wind force (wind mills), but in reality, its procedures were very similar to the trapiches with animals (Egorova 2010).

If we analyze in detail cunningly most revolutionary applied innovation violently driving, that have presented mills within the first colonial centuries, can assert, that was the replacement of two horizontal cudgels because of use of three vertical cudgels started in process contra each other, that made the greater extraction the juice having moved sugar-cane because of process double or threefold grinding and squeezing.

Sugar production demanded a plentiful supply of labour to execute all the work required. Therefore, the progress depended completely on Negro-slaves and their productivity.

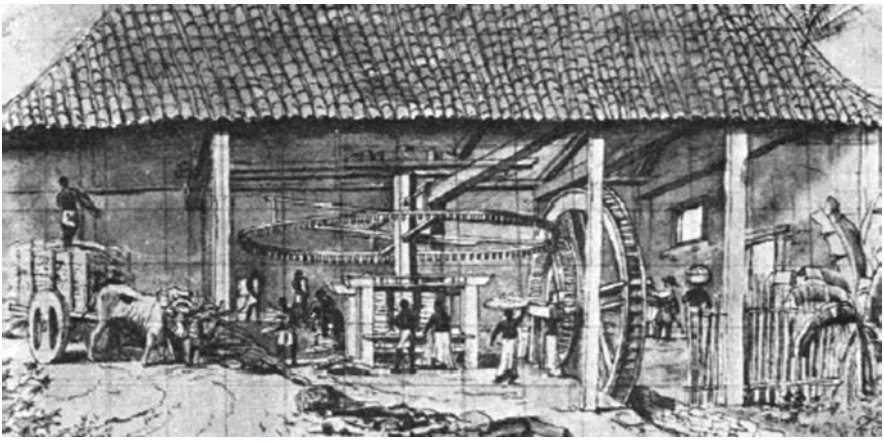

Fig. 19 Sugar-mill (Trapiche) using power of water

It is clear that the Cuban landowners had a talent for sugar production and appreciated the potential benefits of a robust sugar industry, but did not fail to notice the dangers that loomed on the horizon. As evidence of their vigilance, they paid close attention to a new technical development that had been introduced in the world. The first steam machine as a universal engine was constructed in England between 1774 and 1784; as nearly as 1794, Don Francisco de Arango y Parreno and the Count de Casa Montalvo were already in England, looking for an opportunity to make a vapor machine adapted to the necessities of sugar manufacture. They were ready and eager to take advantage of modern technology.

6 A Secret Meeting

We may suppose that Francisco de Arango y Parreno met Agustin de Betancourt in 1794. This conclusion is based on existing data and documents with regard to his long trip with the Count de Casa Montalvo to Portugal, England and its colonies, Barbados and Jamaica, to become familiar with the new technical inventions. Their visit to England coincides with Betancourt's staying in London (Francisco Arango y Parreno 2005).

On October 14, 1795, after having finished his trip, Francisco de Arango spoke to a session of Royal Society about the steam machine ordered in England by the Count de Casa Montalvo; he also made available to the public a small pattern and some drawings of mechanisms of the machine. We have to point out that one of Betancourt's passions was construction of machine patterns, practically exact copies but on a much reduced scale. The existence of this particular pattern points

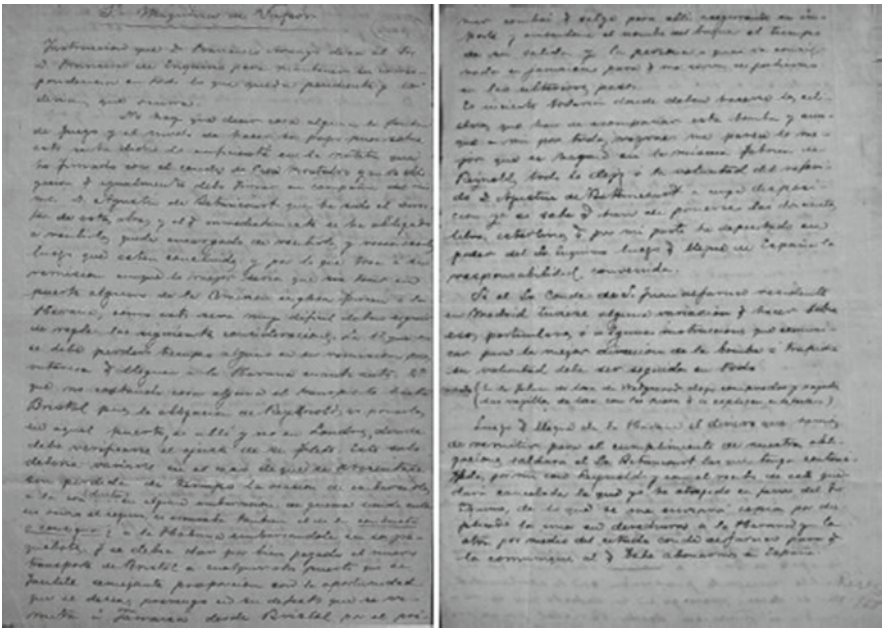

Fig. 20 Original letter written by Francisco de Arango y Parreno

indirectly to authorship of Betancourt in the creation of the mentioned vapor machine because of his great experience in this occupation. In the files of Don Perez Beato of the National Library of Cuba in Havana (BNC), there is preserved, under the number 968, the original letter (Fig. 20) written by Francisco de Arango y Parreno with instructions on reconfiguration and transportation of the steam machine to Cuba (BNC et al. 968). The name of this file is "*The instruction which was left by D. Francisco Arango to Sr. D. Francisco de Enquino to keep his correspondence about everything pendent and the rest that happens*". Here are some fragments of it:

> It's not necessary to say anything about the fire bomb (the steam machine) and the way to make its payment because it has been said enough in the document which I've signed with Count de Casa Montalvo and I also signed an agreement with Don Agustin de Betancourt who has been the supervisor of these works….
>
> …I left everything to Don Agustin de Betancourt's discretion who will receive 200 pounds…
>
> …If Count de San Juan de Jaruco, with residence in Madrid, had to make some variation on these topics or to communicate some instructions for a better transportation of the fire bomb (the steam machine) or trapiche, his will should be followed in everything.
>
> …After having received the money from Havana for fulfilling our obligation, Don Betancourt will pay my bills with Reynolds. It will be also paid Don Equino's debt and the receipts will be sent in two copies. One of them will be sent to Havana and the other to Count de Jaruco for making the payment in Spain.

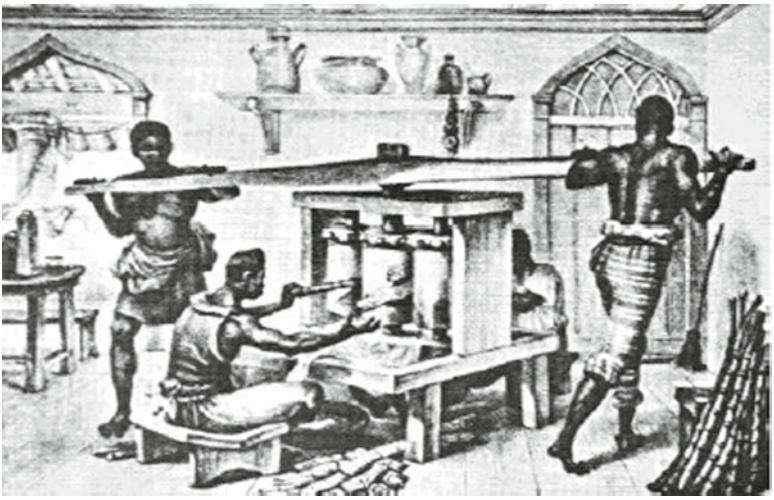

Fig. 21 Sugar-mill (trapiche) using power of Negro-slaves

This letter is the unique document where we can see that Francisco de Arango and Agustin de Betancourt subscribed to an agreement for the production of a new steam machine for grinding of sugar cane. This contract also responded to Betancourt's plans to design steam machines for different technological purposes. In those times, Watt steam machines were unknown in Cuba and the above mentioned machines which used the power of animals and Negro-slaves (Fig. 21) were not so profitable because of their low productivity.

There is also a letter which Betancourt wrote in French on December 10, 1794, to his friend Breguet (Fig. 22) mentioning the received order (García-Diego 1985). This letter, preserved in Breguet's archives, serves as a proof. Among other observations, it says:

> This summer two friends from the Spanish America have been here and I proposed them the project of installing the steam machines in their possessions to avoid the use of oxen and negroes for expelling juice from the sugar cane; I did some calculations and they asked me to produce two of these machines designed by me and they are being done now… Two of these machines will be finished soon and I hope their effectiveness could be seen on the islands and the owners would leave the ones they have now.

It is seen from the text that the order was made by two travelers from "Spanish America" who could well be Cubans. It is obvious that new machines were designed for grinding the sugar cane and were planned to be located in sugar-mills. Francisco de Arango y Parreno and the Count de Casa Montalvo were the owners of vast lands and without any doubt were interested in the use of modern technology and new machines in their sugar-mills. Betancourt's plans for using his machine in future show us that it could be Cuba where the production of sugar was the principal line of economy and all the country was turned into a "world wide sugar-bowl". Cuban saccharocracia kept the power in their hands and for sure were thinking about increasing of the productivity of this industry.

Fig. 22 Abraham-Luis Breguet, fragment (By Goya)

7 The First Steam Machine in Cuba

In a monumental and comprehensive work "The Sugar-mill" ("*El Ingenio*") written by Manuel (Moreno Fraginals 1986), an outstanding investigator of the history of the sugar industry, we can read the following:

> Finally, in 1796, the motive power of the large industry, the steam, arrived in Cuba. It was a machine bought in London with the Count Jaruco`s money. Its installation became a unique event surrounded by an atmosphere of tense expectation. It has been seen to function for the first time on January 11, 1797 at Seybabo sugar-mill and it had been working for several weeks. The experiment wasn't a success but the saccharo-crates didn't lose heart. They understood that the main problem wasn't in the "bomb of fire" (steam machine) itself but in the type of the grinding machine (trapiche) that was moved and in the absurdity of the system of the installed transmission.

Unfortunately, Fraginals and others do not appear to have uncovered a name for the inventor of the above mentioned machine, neither any detail of its construction, nor the data on its moving to Cuba. But a significant fact is that the first steam machine was installed at Seybabo Sugar-mill, which belonged to the Count de Mopox y Jaruco, who led the scientific expedition in which Betancourt and his Spanish colleagues would

have participated. The Count de Mopox y Jaruco was also the son-in-law of the Count de Casa Montalvo who accompanied Francisco de Arango y Parreno in his trip to England. These coincidences make us think that Betancourt was the designer of the first steam machine used for grinding cane in Cuba.

Unfortunately, this machine was broken very soon because there were neither qualified operators nor competent engineers on the Island. In 1796 the Count de Mopox y Jaruco left for his expedition to Cuba, which lasted 6 years, and he could hardly attend to the problems related to the new equipment. In those years, Agustin de Betancourt dedicated himself to the construction of an optic telegraph and to organization of the School of Roads and Canals in Madrid. However he was never able to come to the Island.

8 Agustin De Betancourt as a Pioneer of the Sugar Industry of Cuba

In the book "*Francisco de Arango y Parreno* (2005). *Obras*." we can read the words of Don Diego M. Gardoqui:

> machine was broken… and this unfortunate circumstance has deprived us with a plenty of years of the profit of the most amazing invention of our epoch.

It is true that this first steam machine to be used in Cuba was broken very soon after its installation, within several weeks; but it is important to recognize that the reason was the inability of sugar-mills of that epoch to assimilate this new technology and not because of mistakes in the machine design. Saccharocrates understood also that they needed to change and transform the complete circuit of the technological process. As a result, large-scale use of steam machines in sugar production in Cuba began much later, after 1827. According to Fraginals, more than 20 types of various steam machines were used in different Cuban regions until eventually, a successful one was established in a sugar-mill of Juan de Madraco, in Matanzas. The new steam machine was produced in London by the firm Fawcett, Preston and Co., in 1816, and transported to Cuba through the USA. The time interruption between 1797 and 1816 was due to a lack of international trade, which was related to the ongoing European conflicts, in particular, with Napoleon's wars and consecutive continental blockades. It is necessary also to take into account the peculiar restrictions that occurred in a factory system that functioned on the basis of slavery. And, eventually, we must not forget that England did not want to lose the advantage it had received from the Industrial Revolution and, consequently, the English government made various arrangement to interfere with the distribution of secrets of new machines. Watt steam machines in particular, which could be of the most interest. Because of this policy and its resulting laws, between 1765 and 1789, and even in 1794, no textile machines or related projects were exported, and the emigration of workers specializing in the textile industry or mechanical engineering, in general, was forbidden.

Undoubtedly, the meeting of Agustin de Betancourt with Francisco de Arango y Parreno and the Count de Casa Montalvo influenced greatly on the use of steam machines in Cuban sugar-mills, which is proved by the words of Don Gardoqui:

> we shall be also the first who have forced to carry out through the Atlantic Ocean the most powerful agent that has learned the industry. When it is not possible to use water in nature (water-mill), we could use bombs of fire (steam machines) to move our trapiches and have left for ever expensive, uncertain and weak means of mules and donkeys.

Comparison of archive documents, the "mystery drawing" on the portrait of the Count de Casa Montalvo and some other facts prove convincingly that Agustin de Betancourt was unquestionably the designer of the first steam machine to be installed at Seybabo Sugar-mill and used for the first time in sugar production of Cuba in January, 11, 1797 (Egorova 2010).

Later, steam machines became popular and in 1837 Cuba became the first country in Latin America to have a railway from Havana to one of its Municipios, Guines (Fig. 23), even before the Metropolis had, but in the same year that Russia put one into operation.

In 2003, according to the initiative of Saint Petersburg professors and scientists and with the aim of glorifying the name of the Spanish-Russian engineer , there appeared in the register of small planets of the solar system, the planet "Betancourt" with the number 11446.

Fig. 23 First railway in Cuba (A stamp of Cuba)

9 Conclusion

Our investigation proves convincingly that the designer of the first steam machine used in the sugar industry in Cuba in 1797 was the Spanish-Russian engineer Agustin de Betancourt. This work also stands as a case history in science, emphasizing the role of one dedicated scientist in the person of Betancourt. He epitomizes the role of an individual who stood out in the history of and dialectic interrelation between public consciousness and economic relations, a story that resulted from the one individual leading in pursuit of a process of manufacture on which his own very existence depended.

Agustin de Betancourt was a foremost pioneer in the long history of industrialization in Cuba, and in sugar production in particular. He has cleared a number of scientific roads, exploited a passionate desire for technical progress and has contributed considerably to the establishment of higher technical and engineering education in Russia. His ideas have exerted great influence on the development of modern engineering techniques all over the world. He has earned his place in history.

Acknowledgements I would like to thank all my Cuban, Russian and Spanish friends who helped me to finish my investigation on the first steam machine introduced in the sugar industry of Cuba.

I also hope that the young generation will study much more the History of Machine and Mechanism Science as well as biographies of famous scientists and philosophers.

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